Temporomandibular Disorders: A Position Paper of the International College of Cranio-Mandibular Orthopedics (ICCMO)

"Measure what is measurable and what is not measurable, make measurable." Galileo Galilei

This position paper is endorsed by the Board of Regents of the International College of Cranio-Mandibular Orthopedics, 2011.

ABSTRACT: *Purpose*: Two principal schools of thought regarding the etiology and optimal treatment of temporomandibular disorders exist; one physical/functional, the other biopsychosocial. This position paper establishes the scientific basis for the physical/functional. *The ICCMO Position*: Temporomandibular disorders (TMD) comprise a group of musculoskeletal disorders, affecting alterations in the structure and/or function of the temporomandibular joints (TMJ), masticatory muscles, dentition and supporting structures. The initial TMD diagnosis is based on history, clinical examination and imaging, if indicated. Diagnosis is greatly enhanced with physiologic measurement devices, providing objective measurements of the functional status of the masticatory system: TMJs, muscles and dental occlusion. The American Alliance of TMD organizations represent thousands of clinicians involved in the treatment of TMD. The ten basic principles of the Alliance include the following statement: Dental occlusion may have a significant role in TMD; as a cause, precipitant and /or perpetuating factor. Therefore, it can be stated that the overwhelming majority of dentists treating TMD believe dental occlusion plays a major role in predisposition, precipitation and perpetuation. While our membership believes that occlusal treatments most frequently resolve TMD, it is recognized that TMD can be multi faceted and may exist with co-morbid physical or emotional factors that may require therapy by appropriate providers. The International College of Cranio-Mandibular Orthopedics (ICCMO), composed of academic and clinical dentists, believes that TMD has a primary physical/functional basis. Initial conservative and reversible TMD treatment employing a therapeutic neuromuscular orthosis that incorporates relaxed, healthy masticatory muscle function and a stable occlusion is most often successful. This is accomplished using objective measurement technologies and ultra low frequency transcutaneous electrical neural stimulation (TENS). *Conclusion*: Extensive literature substantiates the scientific validity of the physical/functional basis of TMD, efficacy of measurement devices and TENS and their use as aids in diagnosis and in establishing a therapeutic neuromuscular dental occlusion. *Clinical Implications*: A scientifically valid basis for TMD diagnosis and treatment is presented aiding in therapy.

I. Introduction

The International College of Cranio-Mandibular Orthopedics (ICCMO) was founded in 1979 as an independent dental organization to encourage research, improve clinical practice and education related to objective measurements of the physiology of the stomatognathic system. Studies by Dr. Bernard Jankelson of the physiology of human dental occlusion, published in 1955[1] resulted in recognition of the scientific need to quantify the function of the masticatory system. These studies were a driving force in the development, and then introduction, of a physiologically based, objectively measured concept of dental occlusion, called neuromuscular occlusion. Dr. Jankelson's studies of the physiology of human dental occlusion, were precursors to the neuromuscular occlusion concept he introduced in 1973. Clinically usable devices to measure the function of the components of the masticatory system, the TMJ, muscles and dental occlusion were subsequently invented.[2-4] Objective measurements of masticatory function and dental occlusion, established the scientific validity of the neuromuscular occlusion concept and its clinical utility.

Like other medical disciplines responsible for diagnosis and treatment of musculoskeletal disorders, the use of objective measurement facilitates differential diagnosis and results in improved treatment outcomes for multi-etiologic conditions. Hence, these modalities are tools for diagnosis and treatment of TMD.

ICCMO fosters neuromuscular concepts and practices to alleviate painful conditions related to malocclusion, mandibular, head and neck musculoskeletal dysfunction, including temporomandibular disorders. Members are in both clinical practice and academic institutions, with sections in the USA, Canada, Japan, Italy, Germany, France and South America.

ICCMO members recognize that temporomandibular disorders (TMD) most commonly have a physical/physiological basis with dental malocclusion as a major etiologic agent. They employ neuromuscular occlusal therapies as primary modalities to improve muscle and joint function, utilizing objective measurement data to optimize treatment outcome. These clinical modalities are applied to the

treatment of patients with TMD and others who require significant alteration or restoration to a physiological dental occlusion.

II. Temporomandibular Disorders

Temporomandibular disorders (TMD) comprise a group of musculoskeletal disorders that affect alterations in the structure and/or function of one or more of the following: temporomandibular joints (TMJ), masticatory muscles, the dentition and its supporting structures, and the complex neuromuscular system attached thereto. TMD can coexist with other musculoskeletal disorders within the head and neck area. Each TMD patient has a unique composite of different elements, which can involve the TM joint and masticatory muscle systems, often with the pain and dysfunction of physical causes leading to manifestation of psychological stress.

Signs and symptoms determined upon clinical examination are varied and their prevalences have been the subject of extensive research published in the medical and dental literature. In a classical article published in 1934, Costen, an otolaryngologist, observed that posterior condylar displacement in the TM joint created by the dental malocclusion was the cause of otological symptoms in a group of his patients. Costen inserted a dental device and the symptoms were resolved.[5,6] In a 2007 study performed on 4,528 TMD patients, certain signs and symptoms were found present in extremely large percentages, which helped in the characterization of the TMD patient. In that study, symptoms most commonly reported included: pain 96%, headache 79%, TM joint discomfort or dysfunction 75%, and ear discomfort or dysfunction 82%. The most prevalent examination findings were tenderness to palpation of the lateral and/or medial pterygoid muscles 85% and TM joint tenderness to palpation 62%.[7] In the medical literature related to TMD, the most commonly reported symptoms are headache and otolaryngological.[8-10]

III. The Role of Dental Occlusion in TMD

Dental occlusion is the cornerstone of stability of the craniomandibular system, comprised of dentition, masticatory muscles and the TM joints. Malocclusion is a destabilizing factor, representing a major predisposing condition for TMD. A number of studies have substantiated an association between dental occlusion and TMD. These studies have documented the role of occlusion as a predisposing, initiating and/or perpetuating factor in the etiology of TMD.[11-24]

In other studies that investigated the cause-effect relationship, the authors experimentally induced TMD in asymptomatic subjects by introducing occlusal interferences into healthy subjects and studied the development of signs and symptoms of TMD. Changes in subjective symptoms and clinical indicators of dysfunction were recorded.[25-34] Asymptomatic subjects in all of these studies developed signs and symptoms of TMD, some after only a few hours. According to De Boever, et al.[27] who performed a scientific review of the literature on the relationship between occlusion and TMD, "These studies have shown that artificially introduced occlusal interferences can provoke immediate responses in the contraction pattern of jaw muscles and they may induce jaw muscle hyperactivity and pain in some subjects."

In a three-part study conducted at Karolinska Institute, Riise and Sheikholeslam[28-30] investigated the influence of an intercuspal occlusal interference that was introduced in 11 healthy subjects with no signs and symptoms of functional disorders. According to this study, in less than 12 hours following the insertion of the interfering amalgam filling, signs and symptoms of functional disorders had developed in eight subjects, accompanied by an increase in the EMG postural activity of the anterior temporalis and masseter muscles. The subjects complained of pain, tenderness and fatigue in their facial muscles. The authors concluded that "Within a week after the occlusal interference was removed, the symptoms gradually subsided . . . and postural EMG activity had returned almost to its original pattern in all subjects."

In a randomized double-blind study at University of Turku in Finland, Le Bell, et al.[31-33] conducted their study on two groups of subjects, all women, that consisted of 26 healthy subjects, and a matched group of 21 subjects with a prior history of TMD who were successfully treated. Each group was randomly divided into two groups of placebo and true interference groups. Experimental occlusal interference was introduced in the true interference groups and simulated in the placebo groups. The investigators monitored the clinical signs of subjects in the resulting four groups for two weeks. Additionally, all subjects rated the intensity of their symptoms on a scale relative to their experience of TMD pain and discomfort. The authors concluded, "subjects with a TMD history and true interference showed a significant increase in clinical signs and reported stronger symptoms than subjects with no TMD history and placebo interferences."

These studies demonstrate the presence of several factors when an occlusal interference is introduced. These include the effect of the interference on muscles and joints, the inherent adaptive capacity of the subject, and the influence of suggestion (placebo effect). The results clearly substanti-

ate the role of occlusion in the onset and perpetuation of TMD and a return to normal masticatory function when occlusal harmony is restored.

It is commonly agreed, among dentists who treat patients with TMD, that conservative, reversible therapies should be employed, whenever possible, in the initial phase of treatment. Several studies have concluded that TMD patients experience the greatest clinical success after receiving treatments that involve restoration of optimum function of the mandible, muscles and TM joints, through use of intraoral orthotic appliances of various designs.[35-41] The neuromuscular occlusion orthosis recommended by ICCMO is one form of conservative treatment. Some patients, after undergoing successful initial reversible forms of therapy, do not require long-term occlusal stabilization treatment, while others do require long-term continued maintenance of a therapeutic occlusal position to perpetuate initially affected resolution of TMD. The long-term treatment may involve permanent alteration of the occlusal relationship or continued use of precision orthoses. A small number of patients actually require TM joint surgery to treat dysfunctional joints.

IV. Neuromuscular Occlusion

Neuromuscular occlusion is in harmony with relaxed, healthy muscles and properly functioning temporomandibular joints. It is a stable maxillo-mandibular position of dental occlusion arrived at by isotonic contraction of relaxed masticatory muscles, achieved by stimulation of those muscles on a trajectory (arc) beginning at a muscularly rested mandibular position.[39] Healthy temporomandibular joint (TMJ) function must be accompanied by a stable dental occlusion, freely entered and exited without interferences, dictated by and directed by healthy relaxed masticatory muscles for long-term stability of all of the interrelated structures.

Joints do not initiate or dictate function; they permit function and adapt to functional demands. Healthy TM joint function is not primary, but secondary to a physiological dental occlusion. Form follows function: the shape of hard structures results from the function which they are required to perform.[40] To protect the hard structures (joints, alveolar bones), healthy function must be provided to the soft tissues (muscles, periodontium and ligaments). Hence, it is valuable to analyze function before form to understand how and why anatomical form was changed. For example, it is valuable to analyze the genesis of the severe attrition seen on incisor teeth prior to treatment planning for porcelain laminate veneers, or the same conditions untreated can cause failure of the new restorations. The concept of a neuromuscular dental occlusion has not changed since its introduction in 1973; only the technology used to establish this therapeutic occlusion has been developed and refined.[3]

V. Technologies Used in Neuromuscular Dentistry

It is an accepted physiological axiom that muscles function optimally from their full resting length: a rested state.[41] Implementation of the recognition of the essential role of relaxed masticatory muscles as a prerequisite for the establishment of an ergonomic, optimally physiologic occlusion was the impetus for the development of an instrument capable of affecting true physiological masticatory muscle relaxation. The clinical device developed to relax mandibular elevator and depressor muscles is a neuromuscular stimulator (TENS device) that delivers an intermittent minute, low voltage, low amperage, fixed rate neural stimulus simultaneously to all of the masticatory muscles through the mandibular division of the trigeminal nerve applied over the mandibular coronoid notch.[42-44] The stimulator used is similar to other medical nerve mediated ultra-low frequency TENS devices used to affect relaxation of muscles. In the case of TMD; the mandibular elevator and depressor muscles are the stimulated muscles.[45-51]

Proper diagnosis of any medical/dental condition is made by the treating doctor and begins with obtaining a history of the illness and performing a comprehensive clinical examination of the affected area, employing imaging studies when indicated. The diagnostic process and treatment plan are greatly enhanced using technologies that can scrutinize the anatomic and functional components of the masticatory system, providing reliable and precise objective measurement data. Because of the diversity of structures involved and variability in chronicity and intensity of TMD presentations between patients, there can be no single diagnostic test with an acceptable level of "specificity" to rule TMD in or out. In medicine, there are many devices considered valuable as diagnostic aids, such as radiographs, MRI, and cardiac stress tests that are not free-standing diagnostic devices. Sometimes, more than one device is used to obtain a proper diagnosis.

Within the past four decades, three computerized measurement devices have been developed and refined to record and analyze, with high degrees of precision, masticatory muscle function (EMG), mandibular movements (CMS), TMJ joint sounds (ESG), and dental occlusion as dynamic phenomena.

Surface Electromyography (EMG) is a well-accepted modality with which to evaluate muscle function. A significant body of the scientific literature

published in peer-reviewed journals over the past 50 years has concluded that the TMD patient population has an elevated resting EMG muscle activity and weak or asymmetrical functional EMG muscle activity.[52-96] EMG measures electrical activity in masticatory muscles at rest and in function. This measured activity aids in identification of mandibular rest position as a reference for the selection of the neuromuscular occlusion position, as well as evaluation of the quality of the dental occlusion through the analysis of patterns of muscle motor unit recruitment. Numerous studies have substantiated the reliability and reproducibility of surface electromyography in the evaluation of the status of the masticatory muscles.[97-108] While "normal or physiological values" for electromyographic (EMG) have been published, because morphologic variations from patient to patient can affect EMG readings, EMG data is utilized to compare electrical activity in selected masticatory muscles before and after treatment for a given patient. In research studies, collective data for a group of subjects are similarly compared. The combination of surface electromyography of masticatory muscles and electronic jaw tracking is a clinically useful and objective method of quantifying the physical components of temporomandibular disorders in patients screened for treatment.[109-120]

Computerized Mandibular Scans (CMS) measure and record mandibular ranges of motion, direction, velocity and fluidity of jaw movements, rest position of the mandible and dental occlusion, both natural and therapeutic.

Electrosonography (ESG) records and provides spectral analysis of TM joint sounds, identifying their magnitude and specific frequencies produced by mandibular movements during mouth opening and closing with greater precision than stethoscopic auscultation.[121-124]

These three technologies are not free-standing diagnostic devices; they are precision objective measurement instruments, which aid the dentist in establishing a diagnosis. These devices underwent the review processes of the US FDA in 1997 and 1998[125,126] and the ADA Council on Scientific Affairs in1986 and 1993[127,128] and have been recognized as safe and effective aids in the diagnosis and treatment of patients with temporomandibular disorders.

According to the ADA's Council on Scientific Affairs[129,130] "Surface electromyography, or EMG, is used in dentistry to assess the status of the muscles of mastication.[131] It allows the clinician to assess the resting activity of muscles and determine if muscle spasms are present.[132,133] In particular, EMG instruments measure static and functional muscle activity, including postural hypertonicity and continuous muscle contraction.[133] Evaluation of muscle activity is included among the diagnostic criteria for TMD as given in the ADA Council's Guidelines.... Muscle spasm is included in the counsel's classification system (Section 11.8.3 in the Appendix), and among the diagnostic criteria is continuous muscle contraction at rest. Surface electromyography is one method that can measure such muscle hyperactivity…. There is considerable agreement among both clinicians and researchers that masticatory muscle activity is increased in symptomatic patients compared to normal subjects, and electromyography is one tool that can be used to study such differences."[134] Therefore, EMG devices "were found to meet the [ADA] Council's Guidelines for Instruments as Aids in the Diagnosis of Temporomandibular Disorders."[130]

Neuromuscular measurement devices objectively document patient status, create objective milestones in planning treatment, and document patients' response to treatment.[135-152] The three devices, computerized jaw tracking, electromyography and electrosonography, provide objective documentation of the pretreatment status of patients with regard to mandibular and masticatory muscle function and permit evaluation of treatment outcomes.

Together with these measurement devices, Transcutaneous Electrical Neural Stimulation (TENS) is an active therapeutic device that affects relaxation of masticatory and mandibular postural muscles by use of low frequency, low current stimulation of the mandibular division of the trigeminal nerve (CN V) and a branch of the superficial facial nerve (CN VII).[42-45] It is used during the treatment to achieve true rest position of the mandible and a therapeutic neuromuscular occlusal position.[153-161] Thereafter, TENS is employed as an aide in performing occlusal adjustments of the anatomical surface of the neuromuscular TMD orthosis.

Without objective measurement of function, treatment planning and outcome evaluation are subjective and may be imprecise and possibly inaccurate.[162,163] *With objective measurement*, treatment planning, as well as treatment outcome, whether successful or not, can be scrutinized and evaluated. Treatment can be modified, continued or discontinued, based upon precise objective measurements together with a patient's needs and desires; rather than relying only on subjective evaluations of success by the patient and dentist.

VI. Conclusion

The overwhelming majority of dentists worldwide, treating thousands of patients annually, and whose patients had not previously experienced resolution of their painful and/or

dysfunctional symptoms, support the conclusions reached by a large number of studies that TMD is a physical/functional disorder most often resulting from the mal-relationship among the dental occlusion, masticatory muscles, and TM joint function.[11-34,39,164] They find that their patients are most often conservatively and successfully treatable initially with reversible occlusal orthosis therapy. Members of ICCMO adhere to this principal and treat to establish a healthy craniomandibular relationship through the use of a physiologically balanced neuromuscular occlusion that is in harmony with relaxed, healthy masticatory muscles with improved function and properly functioning TM joints. This achieves a stable, physiologically sound dental and craniomandibular position that does not cause noxious neural input to the central nervous system with resultant adaptive/accommodative function and behavior. In addition to its use in the treatment of patients with TMD, the neuromuscular occlusal philosophy can be successfully applied to all forms of dental treatment that involve major alteration of dental occlusion, including orthodontics, full arch or full mouth reconstruction and complete dentures.

Successful treatment of temporomandibular disorders using neuromuscular occlusion techniques is directed towards elimination of the cause of the disease, not just symptom relief. If the cause is not successfully identified and treated, the acute physical/physiological form of TMD may unfortunately degenerate into a chronic pain condition, rarely cured, and at best, attempted to be managed with pharmacologic and other medical/behavioral therapies. Such symptom-only oriented treatment can adversely affect the patients' ability to work or have normal social interactions, resulting in an overall reduction in quality of life. Published research data demonstrate that the establishment of a neuromuscular therapeutic occlusion provides improved mandibular and masticatory function in a large group of TMD patients with notably significant reduction or resolution of symptoms.[39,152]

The International College of Cranio-Mandibular Orthopedics supports the consensus among its members and thousands of neuromuscular dentists worldwide that TMD has a primary physical/functional component that is most often successfully treated with neuromuscular dental occlusion therapy, based on objective measurements.

Barry C. Cooper, D.D.S.
Lawrence, New York
Email: *tmjbcooper@aol.com*

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Dr. Barry Cooper *received his D.D.S. degree in 1963 from Columbia University School of Dental and Oral Surgery. He is currently a clinical professor, Division of Translational Oral Biology of the State University of New York (SUNY) Stony Brook School of Dental Medicine. Dr. Cooper has held faculty positions at Columbia University School of Dental and Oral Surgery, New York Medical College, and Temple University School of Dentistry. He is past international president of the International College of Cranio-Mandibular Orthopedics (ICCMO). Dr. Cooper maintains a private practice in Hewlett and Manhattan, New York, limited to the treatment of patients with temporomandibular disorders.*